Report of Project Manager

Michael S. Zisman

CENTER FOR BEAM PHYSICS

Muon Collaboration Project Manager

MUTAC Meeting-LBNL
April 25, 2005
Outline

• Introduction

• FY04 accounting

• Recent R&D accomplishments

• FY05 budget

• FY05 plans

• Longer-term plans

• Summary and outlook
**Introduction**

- Since FY03, the **MC** budget has been nearly flat-flat — expected to remain near that level for next several years

<table>
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<tr>
<th>Year</th>
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- Starting this year, we have DOE permission to commit funds to **MICE** — level is $300K (for FY05-07)

- By juggling projects across fiscal year boundaries and careful prioritization, we have continued to make progress — but it is getting harder

- Proposed elimination of BNL muon group would be very harmful to **MC** program, especially if nearly 30% of our funding disappears also
Introduction

• Hardware development continues as major focus of FY05 activity

• Simulation effort aimed at reducing Neutrino Factory cost (“Study IIa”) gave good results
  — a substantial part of the working group report based on this work

• Effort toward MICE is coming to fruition
  — passed Gateway 2-3 review on Phase 1 of MICE in December 2004
    • PPARC released UK funds (£9.7M) in March 2005

• MICE funding is now available from MC funds
  — need more; applied for NSF MRI grant (Kaplan)

• Here I will cover:
  — FY04 accounting and R&D accomplishments
  — FY05 budget and activities
FY04 Accounting

- FY04 budget finalized by Spokespersons and PM in November

- International Muon Ionization Cooling Experiment is starting to become a significant draw on resources
  - last year required mostly “effort” (base program funds)
  - this changed in FY05
    - M&S funding is now needed
**FY04 Accounting**

- **FY04 MC budget (approved by MCOG):**

<table>
<thead>
<tr>
<th>Institution</th>
<th>COOLING</th>
<th>TARGETRY</th>
<th>COLLIDER</th>
<th>EFFORT&lt;sup&gt;a&lt;/sup&gt;</th>
<th>RESERVE&lt;sup&gt;b&lt;/sup&gt;</th>
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</table>

<sup>a</sup> Includes beam simulation and diagnostics effort.

<sup>b</sup> Modest project reserve used to account for uncertainties in R&D activity costs.

- Also: salary support from BNL, FNAL, LBNL; support from NSF (mainly Cornell) of $\approx$1M; and support from ICAR ($\approx$9 FTE).
FY04 Accounting

- Supplemental request submitted to DOE in September, 2003 (priority order)
  - priorities decided in Technical Board discussions
    - DOE approved $400K in July, 2004

<table>
<thead>
<tr>
<th>Item</th>
<th>Request ($K)</th>
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<td>1) 201 MHz RF testing</td>
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</tr>
<tr>
<td>2) LH$_2$ absorber test capability</td>
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<td>3) Targetry magnet fabrication</td>
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<td>4) Coupling coil design and construction</td>
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<td><strong>TOTAL</strong></td>
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FY04 Accounting

• Main goals for FY04
  — begin fabrication of targetry test magnet
  — continue development of MUCCOL Test Area (MTA) at FNAL
  — continue high-power tests of 805 MHz cavity
  — continue 201-MHz SCRF development (NSF supported)
  — continue with LH$_2$ absorber development (includes ICAR support)
  — complete fabrication of 201-MHz NCRF cavity
  — obtain funding for MICE
  — continue exploring and optimizing cooling ring performance

• Aspirations this year consistent with modest budget
Before funds were distributed, each institution provided milestones agreed upon by PM—milestones (example below) reflect budget allocations for each institution, including base program funds.

**FNAL [Geer]**

**Milestone**
- Complete HVAC installation in MTA
- Install 805 MHz RF capability in MTA
- Relocate Lab G solenoid to MTA
- Install 201 MHz RF capability in MTA
- Test solid 4x4 grid structure at 805 MHz
- Test curved Be windows in 805 MHz pillbox cavity
- Study RF buncher, phase rotation and cooling channel performance for APS Neutrino Study
- Complete design of cooled 805 MHz grid structure
- Participate in APS Neutrino Study

<table>
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<tr>
<td>Jun-04</td>
<td>MC note prepared</td>
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<tr>
<td>Sep-04</td>
<td>MC note prepared</td>
</tr>
<tr>
<td>Jun-04</td>
<td>Write-up prepared</td>
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</table>

**ANL [Norem]**

**Milestone**
- Initial tests with field ion microscope
- Prepare proposal for RF surface studies (DOE, DARPA, NASA, or EPRI)
- Prepare paper on MICE cavity surface treatment
- Evaluate 805 MHz pillbox cavity performance with precurved Be windows
- Test breakdown behavior of small samples in 805 MHz cavity
- Calculate shielding requirements for MICE experiment
- Review MICE rf backgrounds for rebaselined configuration

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# FY04 Accounting

- Summary of FY04 spending is shown below

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<tr>
<th>Institution</th>
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<th>Base Program</th>
<th>Overall</th>
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<td><strong>2760</strong></td>
<td><strong>3726</strong></td>
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**NOTES:**

[1] Uncommitted funds for MTA cryogenic system, to be installed in FY05.
[2] Includes $162K in uncommitted Project Reserve funds maintained by LBNL and $250K of FY04 supplemental funds received in August '04.
[3] Includes carryover from FY03.
[4] $38.5K of planned FY04 funding was deferred until FY05.
[5] DOE totals in Roman type; *additional NSF funding shown in italics*. 
Recent R&D Accomplishments

- R&D progress being made on all fronts:
  - Targetry
  - Cooling
  - Acceleration
  - Simulations
  - MICE
Recent R&D Accomplishments

- Proposal for targetry experiment at CERN submitted April, 2004 (and now has final approval “nTOF11”)

  — venue change necessitated by elimination of continued A3 line running at BNL
Recent R&D Accomplishments

- Fabrication of 15 T magnet cryostat under way at CVIP
Recent R&D Accomplishments

— coil winding is also in progress at Everson-Tesla

First layer, coil segment 2
Recent R&D Accomplishments

- Concept for Hg jet system for CERN target test experiment being developed in collaboration with ORNL
  - details still being optimized
Recent R&D Accomplishments

- Planned tests using **pillbox cavity** with replaceable windows, grids, or "buttons"
  - cavity fits in bore of Lab G solenoid
  - tests delayed by abrupt termination of Lab G RF capability in December 2003

"Button" for materials tests

Re-coated waveguide
Recent R&D Accomplishments

• Also plan to test pressurized version of button cavity (Muons, Inc.)
  — use high pressure $H_2$ gas to limit breakdown
  ○ this project also put on hold due to demise of Lab G facility
Recent R&D Accomplishments

- RF test plan has been prepared for both 805 MHz and 201 MHz
  - not yet carried out due to lack of RF test facility
- 805 MHz program will resume as soon as MTA outfitted with RF power
- Initial tests of 201 MHz cavity will also commence
- 201 MHz rf cavity completed (LBNL, Jlab, U-Miss collaboration)
  - cavity presently undergoing low-power tests at Jlab
Recent R&D Accomplishments

- Remaining fabrication steps:
  - clean interior and electropolish
  - attach tuning apparatus and pump
- Expect delivery to MTA in May
- Curved window for 201 MHz cavity fabricated in industry
  - first window completed, another being fabricated now

![Pre-curved Be window (0.38 mm thick)](image)

- Cu frame
- 420 mm
Recent R&D Accomplishments

- Absorber group has developed strong, thin windows
  - new stronger (⇒ thinner) design built (at U.-Miss.) and tested successfully at Fermilab
    - 125 µm window is 3x stronger than original design
    - burst at 140 psi
Recent R&D Accomplishments

- Initial absorber LH$_2$ filling tests carried out at MTA last summer
  - convection-cooled absorber prototype fabricated at KEK
Recent R&D Accomplishments

• Construction of **MU COOL Test Area** at Fermilab completed
  — absorber, solenoid, and 201 MHz rf cavity will be integrated here
  ◦ infrastructure for RF and absorber tests almost completed
Recent R&D Accomplishments

• Work on 201 MHz scrf cavity for the acceleration system has shifted gears
  — now trying to understand Q slope in terms of impurities and Nb coating properties

• Cavity back at CERN for recoating
  — building 500 MHz cavity to study Nb sputtering techniques
    o can study phenomena more cost-effectively with smaller cavity
Recent R&D Accomplishments

• Simulations

  — main focus in past year was to participate in APS Multi-Divisional Neutrino Study (http://www.aps.org/neutrino/)

  — detailed report written by “Neutrino Factory and Beta Beams Experiments and Development Working Group” (led by Geer and MZ)


  — considerable progress made in simplifying front-end systems while maintaining performance

    o developed RF bunching and phase rotation scheme; simplified cooling channel; FFAG scheme for final acceleration stages

  — estimated cost of Neutrino Factory reduced 30–40% by this work

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<td>63</td>
<td>60</td>
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Recent R&D Accomplishments

- Use simplified cooling channel
  - shorter, fewer magnets and cavities, simpler absorbers (replace LH$_2$ with LiH)
  - performs acceptably for both $\mu^+$ and $\mu^-$ (with larger downstream acceptance)
Recent R&D Accomplishments

- Looked at FFAG scheme for cost-effective acceleration
  - below 5 GeV, linac + RLA scheme looks more cost effective
  - required combined-function dipoles appear feasible and affordable
  - discussion of building an electron model of FFAG continues
FY05 Budget

• Prepared initial budget for FY05 based on guidance of flat budget
  — Tech Board discussed and approved it

• Budgetary “goal” is to maintain university programs while making some progress on key fabrication activities

• More recently, got permission from DOE to earmark $300K to MICE (for 3 years)
<table>
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<tr>
<th>Institution</th>
<th>COOLING /MICE</th>
<th>TARGETRY</th>
<th>ACCEL./COLLIDER</th>
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\(^a\)Includes beam simulation and diagnostics effort.

\(^b\)Includes MICE funding of $300K.

\(^\dagger\)Also: salary support from BNL, FNAL, LBNL; support from NSF of $1M (uncommitted from last year)
FY05 Budget

• Supplemental request submitted to DOE in September 2004 (priority order)
  — priorities decided in discussions between Spokespersons and PM
    ○ no response from DOE yet (and I’m not optimistic)

<table>
<thead>
<tr>
<th>Item</th>
<th>Request ($K)</th>
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<tbody>
<tr>
<td>1) Targetry magnet cryogenics system</td>
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<tr>
<td>2) Coupling coil design and construction</td>
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<tr>
<td>3) Tests of RF surface techniques</td>
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<td><strong>TOTAL</strong></td>
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FY05 Plans

• Targetry
  – complete fabrication of 15 T magnet and refurbish power supply

• Cooling
  – test 201 MHz high-gradient cavity (17 MV/m)
  – test 805 MHz cavity with curved window, grid, and “buttons”

• Acceleration
  – study Q disease and develop mitigation techniques
  – continue design work on FFAG-based systems

• Simulations
  – continue developing cost-optimized front-end for Neutrino Factory
  – explore realistic Muon Collider scenario(s)
FY05 Plans

• **MICE**
  - develop plan for component fabrication
  - assemble and test prototype tracker
  - continue to seek funding

• **Management**
  - develop 5-year R&D plan for MCOG and MUTAC

*Yes, even we must work sometimes!*
Longer-term plans

- Continued low funding and launching of MICE pose challenges for the MC
  - MCOG has asked us (Geer, Palmer, MZ) to prepare a 5-year R&D plan and indicate the corresponding funding needs
    - realistic plan should assume “flat-flat” funding (baseline)
    - optimistic plan could perhaps double our directly funded program
- MCOG wants evidence that we have a plan and that we have (roughly) the wherewithal to follow it
- Strawman budgets developed for two funding scenarios
  - activities lumped into four broad categories
    - **Cooling**: MUCOOL component R&D
    - **Targetry**: development of high power targets and collection systems, including beam tests at BNL, CERN, or elsewhere
    - **System Studies**: work on acceleration, ring coolers, colliders, performance studies
    - **MICE**: purchase or fabrication of MICE components
Longer-term plans

• Summary of baseline (flat-flat) case is

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<thead>
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<th>FY05</th>
<th>FY06</th>
<th>FY07</th>
<th>FY08</th>
<th>FY09</th>
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</table>

— comments:

• assumes base program funds remain as now: BNL ($1.0M); Fermilab ($0.6M); LBNL ($0.3M)

  “threat” to BNL base program adds uncertainty to plan

• priorities in FY05–07 are CERN Targetry experiment and first MICE spectrometer solenoid

• allocation of MICE funding depends on what happens with NSF MRI proposal

• split between Cooling and MICE somewhat flexible
Summary and Outlook

• Past year productive but more difficult than usual for the MC
  — fabrication of Targetry test magnet progressing
  — 201 MHz NCRF cavity fabrication making progress
  — cost-effective Neutrino Factory design developed ("Study IIa")
  — improved absorber window design tested, and first absorber filled with LH₂ (slowed by ICAR demise)
  — SCRF cavity R&D direction changed to “get back to basics”
  — Muons, Inc. initial gas-filled cavity tests encouraging

• MICE gaining momentum
  — PPARC approval for Phase 1 given (£9.7M); some U.S. funding in place (DOE: $900K over 3 yrs; NSF: $300K over 3 yrs)

• Strong MUTAC and MCOG endorsements of R&D accomplishments and plans are needed to maintain or enhance our budget
  — MC will continue to hold up its end of the bargain!